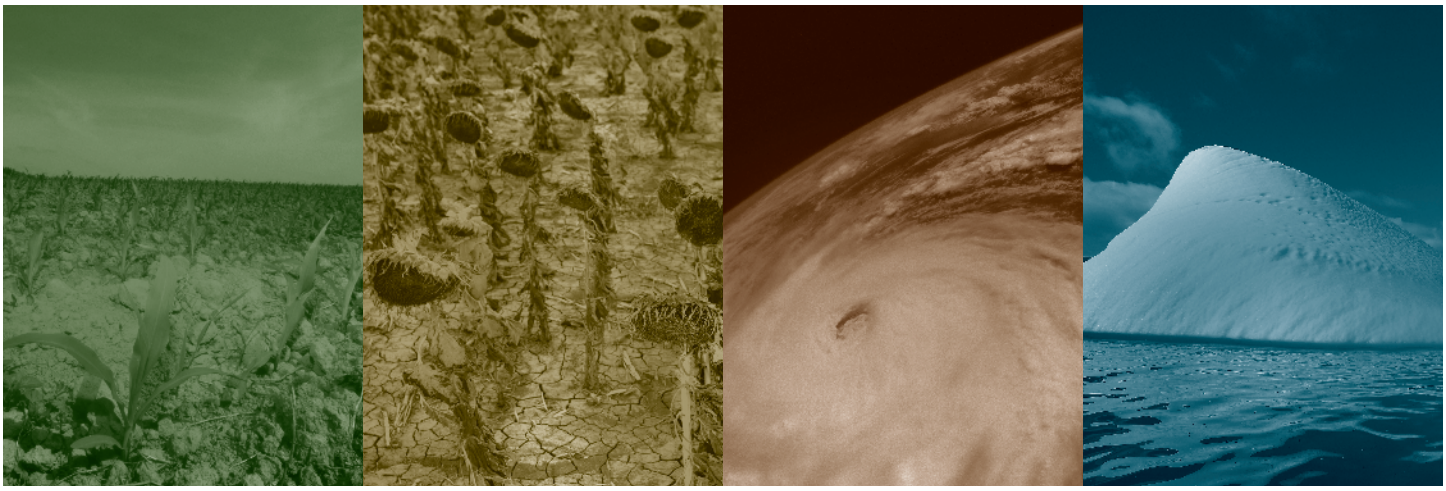
# The Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation



## Climate and Health Technical Report Series

### Climate and Health Program, Centers for Disease Control and Prevention


Stasia Widerynski,[1] Paul Schramm,[1] Kathryn Conlon,[1] Rebecca Noe,[2] Elena Grossman,[3] Michelle Hawkins,[4] Seema Nayak,[5] Matthew Roach,[6] Asante Shipp Hilts[5]

*[1]Climate and Health Program, Division of Environmental Hazards and Health Effects (DEHHE), National Center for Environmental Health (NCEH), Centers for Disease Control and Prevention (CDC)*

*[2]Health Studies Branch, Division of Environmental Hazards and Health Effects (DEHHE), National Center for Environmental Health (NCEH), Centers for Disease Control and Prevention (CDC)*

*[3]University of Illinois at Chicago*

*[4]NOAA National Weather Service*

*[5]New York State Department of Health, Center for Environmental Health*

*[6]Arizona Department of Health Services*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National Center for Environmental Health
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# Executive Summary

Extreme heat is a major public health concern in the United States. The trend of increasing frequency and duration of heat events ("heat waves") is expected to continue in the future. Exposure to extreme heat can cause a variety of health problems, including heat stroke and even death. Public health departments, their partners, and other government organizations have undertaken a variety of strategies to protect the public from high temperatures. The use of cooling centers, a cool site, or air-conditioned building designated as a safe location during extreme heat, is a common strategy. This document is intended to give a summary of the effectiveness of cooling centers, with a focus on highly relevant peer-reviewed literature. It also provides an overview of steps for the implementation of cooling centers.

# Background

As the most recent US Global Change Research Program report notes, changing climate conditions are a threat to human health, with negative impacts expected to increase in the future.[1] Heat-related illness is one health impact that will be affected by climate change. Temperatures have already increased across much of the United States, with an average increase of 1.3°F to 1.9°F since record keeping began in 1895.[2] The most recent decade was the warmest on record, and globally 2016 was the warmest single year since modern record keeping began.[3] This temperature increase is projected to continue, with longer, more severe, and more frequent heat waves expected.[1]

Heat endangers human health in many ways, under many different scenarios. Long term temperature increases, extreme heat events, heat-related drought, high nighttime temperatures, and urban heat islands all impact health. Heat-related illness is one health impact that will be directly affected by climate change. Health effects include heat cramps, heat exhaustion, heat stroke, and death.[4,5] Extreme heat events can be characterized by temperatures that are much warmer than the seasonal average. Exposure to several days of extreme heat, sometimes called heatwaves, have a potential to cause a large number of deaths in a short time period. The 1995 Chicago heat wave resulted in over 700 deaths and thousands of cases of heat-related emergency room visits.[6] In some years, heatwaves cause more deaths in the United States than any other weather-related disaster, including hurricanes and tornadoes.[7,8] The exact number of deaths is difficult to quantify as heat is often not mentioned as a specific cause of death on death certificates, potentially leading to an underestimation of the health impacts of heat.[9] Outside workers, older adults, children, communities of color, the homeless, individuals with a mental health disability, individuals with chronic medical conditions, individuals without access to air-conditioning, and low-income communities are particularly vulnerable to heat-related illness.[10]

Heat-related illness is largely preventable, and health departments, federal agencies, state and local governments, and others are taking steps to prepare for warmer temperatures in a changing climate. Some health departments are utilizing The Centers for Disease Control and Prevention's (CDC) Building Resilience Against Climate Effects (BRACE) framework to help prepare and implement adaptations to protect health.[11] During step three of BRACE, "assessing public health interventions," health departments may choose to examine the usefulness of various heat adaptations in their jurisdiction.

There are many tools and programs that can be used to protect the public from extreme heat, including adoption of a heat-alert system, use of real-time data and surveillance to monitor health outcomes during heat events, built environment strategies (e.g., tree-planting, cool roofs), zoning regulations, heat safety education campaigns, wellness checks, and hydration stations. A health department may not have the authority, resources, or expectation to implement most interventions, but can be an important leader and partner.

One potentially effective and widely used adaptation option is the implementation of cooling centers.[5,12] Access to air conditioning can prevent heat-related morbidity and mortality.[13] Low-income populations may have limited access to air conditioning[12] or may be hesitant to operate air conditioning and cooling units due to potentially high electricity costs during peak heat hours. Cooling centers can provide a cool environment for these individuals. Although there is currently limited direct evidence of the direct health impacts of cooling centers in the peer-reviewed literature, cooling centers are commonly used across the US.[14] They are a relatively low-cost strategy that can utilize existing infrastructure and personnel and be relatively easily implemented by a variety of stakeholders. Their use has a high biological plausibility for reducing heat-related illness and death. Heat is a well-known health threat, and it is logical that a relatively cool environment reduces heat exposure and prevents negative health outcomes. However, the best strategies for effective implementation of cooling centers are unclear. Figure 1 outlines the simple pathway by which implementation of cooling centers protects health.

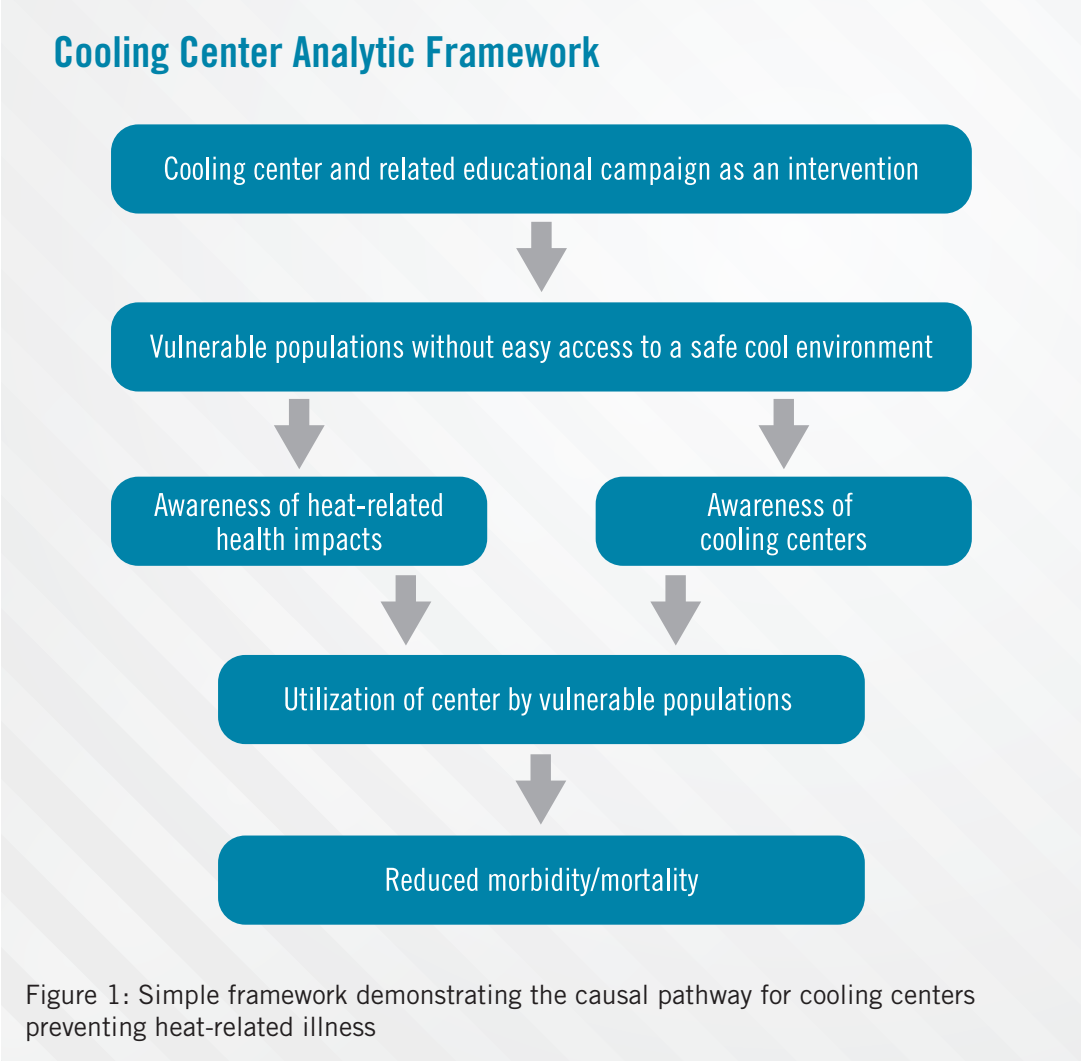


Figure 1: Simple framework demonstrating the causal pathway for cooling centers preventing heat-related illness

## What is a Cooling Center?

A cooling center (or "cooling shelter") is a location, typically an air-conditioned or cooled building that has been designated as a site to provide respite and safety during extreme heat. This may be a government-owned building such as a library or school, an existing community center, religious center, recreation center, or a private business such as a coffee shop, shopping mall, or movie theatre. Some counties have set up cooling sites outdoors in spray parks, community pools, and public parks. Sometimes temporary cool spaces are constructed for events such as a marathon or outdoor concert.


Signs for free water at a cooling center in Maricopa County, Arizona.
Photo credit: Travis L Williams Family Service Center.

No one group or agency is responsible for the implementation of cooling centers. They may be operated by a health department, city government, non-profit groups, or a combination of agencies and/or partners.

This document highlights the existing scientific evidence for use of cooling centers, describes known best practices and considerations for implementation, and outlines research gaps that could be addressed.

# Literature Summary: Effectiveness of Cooling Centers

## Cooling Centers: A Review of the Literature

The literature search methodology is described in the appendix. The initial search strategies resulted in more than 600 references, including peer-reviewed literature, grey literature and reports (documents that are not peer-reviewed but are produced by experts or relevant practitioners), and newspaper articles. Expert opinion was sought to identify any other key resources on cooling centers, especially additional grey literature. 17 highly relevant peer-reviewed articles and 3 relevant grey literature sources were identified. The major findings of these resources are described in the following section and summarized in Figure 2 below.

| AUTHOR (YEAR) | TITLE | METHODS | KEY RELEVANT FINDING OR OUTCOME(S) |
|---|---|---|---|
| Palecki, et al. (2001)[15] | The Nature and Impacts of the July 1999 Heat Wave in the Midwestern United States: Learning From the Lessons of 1995 | Comparative and analytical review of heat waves that occurred in the Midwest focusing on Chicago and St. Louis. | The Chicago 1999 heat wave had 80% less mortality than 1995. Some newspapers reported that retail activity was actually up slightly; people went to shopping malls, and movie theaters had above average attendance as people tried to escape the heat in air conditioned facilities. Heat plans were implemented in the wake of the 1995 heat wave. A heat warning system and cooling centers were opened prior to the 1999 heat wave. These actions resulted in a decrease in deaths for Chicago in the 1999 heat wave as compared to the 1995 heat wave. |
| Kovats, et al (2006)[16] | Heatwaves and Public Health in Europe | Review of public health aspects of heat waves and evaluation of the effectiveness of public health responses in Europe. | Evidence shows that cooling centers are used by more low risk individuals compared to high risk individuals. Identified a need to encourage at risk individuals to visit cool areas. |
| Vandentorren, et al (2006)[17] | August 2003 Heat Wave in France: Risk Factors for Death of Elder People Living at Home | Interview of family members of the deceased from 2003 French heat wave. Calculated odds-ratios. | Utilization of a cool space resulted in reduced mortality during the 2003 European heatwave. |
| Bouchama, et al (2007)[18] | Prognostic Factors in Heat Wave Related Deaths: A Meta-Analysis. | Literature review: meta-analysis. Calculated odds-ratios. | Meta-analysis of five studies found that utilization of a "cool environment" resulted in reduced mortality. |

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| AUTHOR (YEAR) | TITLE | METHODS | KEY RELEVANT FINDING OR OUTCOME(S) |
|---|---|---|---|
| Sheridan (2007)[19] | A Survey of Public Perception and Response to Heat Warnings across Four North American Cities: an Evaluation of Municipal Effectiveness | Telephone interview of residents of four cities (Philadelphia, Phoenix, Dayton, and Toronto) to determine their behavior during a heat wave. | Less than half of respondents modified their behavior during a heat wave. Few opted for cool spaces, but those that did went to malls. |
| Bedsworth (2009)[20] | Preparing for Climate Change: A Perspective from Local Public Health Officers in California | Interviews of local public health officers in California. | Almost all (30/34) jurisdictions had a heat emergency plan in place. All plans include cooling centers but very few provided transportation and even fewer provided financial assistance to low income residents to help with additional cooling costs. |
| Kosatsky, et al (2009)[21] | Heat Awareness and Response among Montreal Residents with Chronic Cardiac and Pulmonary Disease | Interviews of Montreal residents with chronic diseases. | When 238 elderly patients in Quebec, Canada were interviewed about their heat wave habits, 25% of them stated that they would refuse to be sheltered in the event of a prolonged heat wave due to the idea of sleeping in a dormitory or not seeing themselves as ill enough to need it. |
| Alberini, et al (2011)[22] | Individual and Public Program Adaptation: Coping with Heat Waves in Five Cities in Canada | Interviews from residents from 5 cities in Canada. | More than half of respondents didn't know about cooling centers. Knowledge of cooling centers varied by location. |
| Cusack, et al (2012)[23] | Extreme Weather-Related Health Needs of People Who are Homeless | Interviews with vulnerable populations in Adelaide, Australia. | Found that it was difficult for homeless individuals to utilize a public cool space. The authors suggested longer cooling hours for homeless services or cooling centers. |
| Sampson, et al (2013)[24] | Staying Cool in a Changing Climate: Reaching Vulnerable Populations During Heat Events | Interviews with vulnerable populations in four U.S cities (Detroit, Phoenix, New York City and Philadelphia). | Many respondents did not see themselves as vulnerable to heat. Others were hesitant to go to cooling centers because they are unsure of what they provide and don't want to sit in a room with nothing to do. |
| Lane, et al (2013)[25] | Extreme Heat Awareness and Protective Behaviors in New York City. | Interviews with vulnerable populations in New York City. | Many of the vulnerable individuals interviewed didn't feel they were vulnerable, didn't want to be surrounded by "old people," or feared leaving their house unoccupied for long periods of time. |

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| AUTHOR (YEAR) | TITLE | METHODS | KEY RELEVANT FINDING OR OUTCOME(S) |
|---|---|---|---|
| White-Newsome, et al (2014)[26] | Strategies to Reduce the Harmful Effects of Extreme Heat Events: A Four-City Study. | Interview data from counties on how they prepare for heat events in four cities in the U.S. | Each city had a different heat action plan in place. Respondents reported that the only people that use cooling centers are "old people" and they are "not for me." |
| Bradford, et al (2015)[27] | A Heat Vulnerability Index and Adaptation Solutions for Pittsburgh, Pennsylvania | Calculated a heat vulnerability index (HVI) for use in choosing optimal cooling center locations in Pittsburgh, Pennsylvania. | Describes how to use GIS to locate the most vulnerable areas and situate additional cooling centers. |
| Uebelherr, et al (2015)[28] | Innovative Participatory Agent Based Modeling Using a Complexity Governance Perspective | Used participatory modeling and complexity governance to create a heat relief network. Review and lessons learned in Maricopa County, Arizona | Reviews how a county created a heat relief network (including planning for cooling centers) using stakeholder engagement. |
| Nayak, et al (2016)[29] | Surveying Local Health Departments and County Emergency Management Offices on Cooling Centers as a Heat Adaptation | Cooling center evaluation of local health departments in New York State. | Only 29% of counties had cooling centers implemented in their area. Some counties said they have no plans to set up cooling centers due to the lack of need, limited resources, or low attendance in the past. Some counties reported that outdoor cooling sites such as public pools and parks were used more often than indoor cooling centers. |
| Fechter-Leggett, et al (2016)[30] | Heat Stress Illness Emergency Department Visits in National Environmental Public Health Tracking States, 2005–2010 | Quantitative data. Analyzed heat stress illness emergency department visit counts 2005–2010 in 14 states. | Higher rate of heat stress illness emergency department visits were seen in rural areas. There are many reasons this could be the case, one being that there are fewer designated cool spaces. |
| Berisha, et al (2016)[31] | Assessing Adaptation Strategies for Extreme Heat: A Public Health Evaluation of Cooling Centers in Maricopa County, Arizona | Cooling center evaluation described visitor demographics, facility descriptions, and management practices of the centers in Maricopa County, AZ. | Cooling centers in Maricopa County mainly were found within community, senior, or religious centers, discovered by word of mouth or by having seen the cooling center's location. Many visitors self-reported as unemployed or homeless. |

Figure 2: Findings from Key Relevant Peer-reviewed Articles

# Peer-reviewed literature summary

This section summarizes the key findings in scientific peer-reviewed literature related to the implementation and usage of cooling centers, and the context in which they are used.

## Impact of cool environments

Studies indicate that spending even a few hours in a cool environment, or with a working air conditioner or cooling unit, reduces vulnerable populations' risk to heat exposure.[5,12,18] Those who adjust their behavior to include spending time in a cool place during a heat wave are less likely to suffer from heat wave mortality.[17] An analysis of the 2003 European heat wave surveyed family members of the deceased individuals to determine behavior factors that influenced mortality. The study found that spending time in a cooler environment during a heat event was associated with a lower risk of death.[17] A meta-analysis on the risks and protective factors associated with heat-related mortality identified that the act of visiting an air-conditioned space (not necessarily a cooling center) reduced risk of mortality by roughly 66% compared to those who did not visit air-conditioned spaces.[18]

## Cooling centers as part of a larger strategy: heat health warning systems

Cooling centers are a commonly used intervention, typically implemented as part of a larger heat health warning system (HHWS).[20,31] A HHWS can consist of myriad activities such as early alerts, advisories and emergency measures that are often tailored to a specific locale.[32] Studies have shown that HHWS have reduced mortality during heat events.[33,34] HHWS are also colloquially referred to as "heat action plans" or "heat warning systems". HHWS and simultaneous public health response plans have grown increasingly popular after several prominent extreme heat events caused wide spread mortality. The City of Chicago and the Government of France created thorough public response plans after their deadly heat wave events in 1995 and 2003 respectively. Both plans included cooling centers as "boots on the ground" interventions. While cooling centers can serve as a means to provide shelter to larger groups of people, O'Neill et al noted that this protective strategy assumes that those who may need to use the centers most are aware that they're at risk to extreme heat and have adequate transportation to the centers.[35]

Interventions for heat wave events, such as establishing cooling centers, are difficult to evaluate because no two heat wave events, and the populations that are affected, are exactly alike. Case studies can help to draw comparisons between the effectiveness of implemented interventions during comparable heat waves. For instance, Palecki, et al[15] compared the heatwave that struck Chicago in 1995 with the July 1999 heatwave that heavily impacted St. Louis and Chicago. The meteorological intensity of the two events was comparable, though the 1995 event began and ended more abruptly. Unfortunately, the 1995 heat wave was responsible for nearly 700 deaths.[36] Soon after, the City of Chicago began planning a HHWS. The HHWS included interventions such as cooling centers, heat health hot lines, and enhanced warning communication and emergency communication with the National Weather Service (NWS).[37]

While the individual contribution of cooling centers wasn't assessed during the 1999 event, cooling centers were integral to the heat adaptation strategy and warning system. Chicago opened 34 cooling centers, provided free bus service to anyone needing to reach a center, and opened 31 schools to provide more cooling spaces. In addition to these formal city-operated cooling centers, newspapers at this time reported an increase in retail activity, "people went to shopping malls, and movie theaters had above average attendance as people tried to escape the heat in air conditioned facilities."[15] On the fifth hot day, the city advised residents to visit cooling centers after finding low attendance during the previous days. It was reported that many individuals were afraid to leave their homes because they feared their houses being robbed. Over 1,200 people were brought to cooling centers in Chicago during the heat wave.

Because heat waves were common in the Midwest during the 1980s, St. Louis was prepared for heat events. During the 1995 heat wave, a heat alert was issued jointly by the St. Louis Department of Health and the St. Louis County Health Department.[38] There were 27 heat-related deaths reported. The 1999 heat wave was longer in duration compared to the 1995 event. The city identified 36 heat-related deaths. The heat plan in place included designating cooling centers and employing city workers to perform wellness visits on elderly individuals. Although there was an increase in mortality during the 1999 heat wave in St. Louis as compared to the 1995 event, Palecki et al postulate that without a cohesive heat plan in place it would have undoubtedly killed more.[15] The region reported nearly a quarter the number of heat-related deaths during the 1999 heat wave compared to the 1995 event, suggesting that these interventions effectively decreased mortality associated with extreme heat.[15]

## The role of health departments and local governments: summary of surveys on local needs and the implementation and use of cooling centers

Ongoing work in Maricopa County, Arizona, has contributed to knowledge on utilization of cooling centers. The Maricopa County Department of Public Health, Arizona Department of Health Services, and Arizona State University evaluated cooling centers and the services that they provided to visitors.[31] The evaluation encompassed three surveys taken by 658 visitors, 52 facility managers, and an observational site survey. The project was undertaken to gain an understanding regarding the capacity of the centers to provide relief during extreme heat events. The facility manager survey was an in-person interview created to collect information on the facility, capacity, utilization and types of services and supplies offered. The cooling centers are located in many different facility types, the most common is in a community center (n=16, 31%) or senior center (n=16, 31%), followed by religious facility (n=7, 13%), and other (n=13, 25%) (e.g., rehab/recovery, parks and recreation, homeless shelter, government office building).[31,39] Facilities were open mainly Monday through Friday (90%) 6 am to 6 pm (54%).[40] Facility staff indicated that although visitors came at all times of the day noon to 4 pm had the most amount of visitors (61%) on average. Those that responded had the most amount of visitors in July and August and the lowest amount of visitors in September. Facilities mainly communicate their cooling center and services by word of mouth (54%) and print

materials (33%). 71% provided food and snacks, while 27% provided entertainment. All provide free water, 50% go through one case (i.e. 24 bottles) per day, and 25% go through four or more cases per day. 62% report no additional costs associated with using their facility as a cooling center, 23% said additional staff hours are an additional cost, and 17% said that bottled water is an additional cost. The observational survey was an in-person survey taken by evaluators to gauge cooling center facility type, visibility, accessibility, utilization, features and amenities. 67% of the cooling centers in this evaluation did not have clear or visible signs notifying the public of their existence.[39] Of those who did have a sign (n=17) only 7 had the sign in both English and Spanish, the main languages in Maricopa County. 90% (n=47) were easily accessible, 10% (n=5) may not have been easy to enter or use for a disabled person.

A survey in New York State also evaluated cooling center utilization and procedures. Nayak, et al[29] collected the locations, organization, and information on utilization of cooling centers. The authors identified 377 cooling centers in NYS through searching counties' online resources, American Red Cross chapters, and by administering a survey to local health departments and county emergency management offices. The survey was answered by 36 local health departments and 26 emergency management offices, with 62 responses total. Responses came from 56 of the 57 counties surveyed (98% response rate). Only 16 of the 56 (29%) counties surveyed replied that they had cooling centers as part of their response to heat wave events. Five counties did not have cooling centers, but provided cool down information to the public. Thirty five percent (n=19) of counties said they have no plans to set up cooling centers due to the lack of need, limited resources, or low attendance in the past. Participants in this study responded that NYS currently has relatively mild summers and many health departments see cooling centers as unnecessary. This study suggests that more education and outreach is needed in those communities to communicate that due to individual's low adaptation to heat they may be more affected when heat increases in the future. Some counties reported that outdoor cooling sites such as public pools and parks were used more often than indoor cooling centers during heat waves. Almost all cooling centers in NYS provide free water and air conditioning. Although a majority of the cooling centers were accessible by public transportation (76%), few counties provided special transportation to the vulnerable (13%). Almost all of the counties (90%) disseminated their information to the public through the radio, followed by social media, then newspapers. Other methods of information dissemination included calling home care agencies and engaging church groups in the community.

A study surveyed California's county public health departments (n=61) regarding their preparedness to deal with climate change events including extreme heat events.[20] Most county health departments in this study cited heat as the most serious threat to their region's public health in the future. Out of the 34 responses, 30 had a heat action emergency plan available (88%), all included cooling centers and a process for identifying vulnerable populations. In many cities the cooling centers are located in government buildings and community centers. In California, lower income households are less likely to have air conditioning and may not have access to public transit. Almost all (90%) of the responding county public health departments said they had programs that reached out to vulnerable populations in their community. Only 32% reported they provided transportation to cooling centers and 12% provided financial assistance to help with additional cooling costs.

In a study by White-Newsome et al,[26] the authors conducted qualitative interviews with local governments in four U.S cities (Detroit, New York City, Philadelphia, and Phoenix) to understand their public health response plans to extreme heat and their attitudes toward cooling centers as a plausible intervention. This study highlighted some useful "lessons learned" on promoting and using cooling centers. Detroit provided real time information of the location of cooling centers but mentioned the challenges they have with the perception of cooling centers being "just for old people," therefore limiting other vulnerable groups from using them. New York City has an established and organized command system to create their HHWS. The public health department coordinates with the NWS to create a plan before each heat wave is expected to begin. The health department opens cooling centers and starts a public health messaging campaign targeted to educate older populations about the risks of heat and the benefits of using cooling centers. Cooling centers are setup throughout the city in libraries, public housing, the Salvation Army and other public buildings. Philadelphia has all cooling center locations and numbers on the Office of Emergency Management webpage. They reach out to vulnerable populations with pamphlets and brochures in 7 different languages and at community churches. Philadelphia has created many vital partnerships such as the Corporation of Aging, Fire Department, PECO (the electric company), the Environmental Health Services unit, faith based community leaders, and relevant Non-governmental organization (NGO's). All partners work together from a predetermined plan and execute heat warnings to vulnerable populations. Of the four cities surveyed in this study, Phoenix has the most days of extreme heat, 26 days over 110 F on average each year, and has an emergency heat action plan in place. Maricopa County has a large network of over 58 private and public buildings that volunteer to be used to provide cool spaces for residents.[26,31] The Maricopa Association of Governments and volunteer partners help coordinate collections of donations of water and other items to meet basic needs. These items can be distributed in local cooling centers. There are separate cooling centers for the homeless where they can sit down in a cool area and have access to free bottled water and water fountains. Some provide additional accommodations for homeless individuals such as food, clothing and referring services to shelters, mental health care and food banks.[26]

## Individual level data on usage of cooling centers and barriers to use

Berisha and colleagues[31] provide an overview of the populations utilizing cooling centers in Maricopa County, Arizona. Visitor surveys had 658 responses. Of the respondents, 84% were unemployed, 59% were female, 55% were over 45, and 23% were over 65. 33% of the visitors had no permanent residence and 11% of those who indicated a permanent residence had no air conditioning unit at their place of living. Of the total visitors, 27% indicated that they could not use their A/C due to costs, having a broken or malfunctioning unit, or for an otherwise unidentified reason. 50% of the survey respondents identified themselves as being part of the vulnerable population whose health is at risk due to high summer temperatures in Arizona. Nearly two-thirds of respondents reported using a cooling center prior. Of those that indicated they had visited a cooling center before, 67% stated they visit cooling centers 3 or more times throughout the summer months. On average, 60% of visitors spend more than one hour in a cooling center during their visits. 78% visit for the services that the center provides and 22% visit to get out of the heat. Most travel to

the cooling center using a personal vehicle (33%), or by walking (32%), and 23% use public transportation. 29% found out about the cooling center by seeing the location in person, followed by 28% finding out by word of mouth. 61% of respondents visiting the cooling centers mentioned they found out about excessive heat warnings by television, followed by 22% through word of mouth.

Sampson et al conducted 173 interviews with community members and organization leaders in Phoenix, Arizona; Detroit, Michigan; New York City, New York; and Philadelphia, Pennsylvania.[24] Many did not recognize their own vulnerabilities, citing that those "older" than them should be worried, that they've lived in the area for some time and thus have adapted to the heat, or that they have been fine before. The respondents also mentioned places in their neighborhood where they would go to keep cool including public spaces like pools, libraries, senior centers and churches, and private spaces like malls and movie theatres. Barriers to accessing cooling centers were discussed widely, many being brought up by the community members and organizers. Many individuals had questions and concerns about what the cooling centers provide, and are hesitant to travel to an unfamiliar place. They wonder if they would just be sitting in a room with nothing to do. If they are able to go, many don't want to leave their home, or their animals alone. Some low-income individuals cannot afford to travel to malls or other cool places that are sometimes not located near a bus route. Travel was raised as a barrier in all cities discussed in the interview. Waiting at a bus stop on a hot day and the cost of a ride limits people from wanting to use public transit. Although many cited free or reduced cost transportation programs positively, not everyone used these services.

While it is not easy to identify all of the barriers that impact cooling center use, some studies[24,26] have reported that stigma surrounding attending a cooling center, accessing the cooling center, and the difficulties that accompany leaving one's home, are the most notable reasons for limited cooling center use. Focus group respondents reported viewing cooling centers as resources meant for older adults or the homeless. Proper access to public transit inhibits some populations from cooling center use. This study indicates that to make a cooling center successful and efficient individuals need safe and reliable transportation to the center and the organizations involved must learn the most ideal areas to open them to serve the largest vulnerable population.

Sheridan et al[19] showed the geographic differences of extreme heat and cooling center behavior throughout North America. They conducted a telephone survey of 908 individuals in four North American cities (Dayton, Philadelphia, Phoenix, and Toronto). Half of the total older adult population got their heat warning from the newspaper (51%), and only 3% of this population had heard about it from the internet. Although approximately 9 out of 10 of the surveyed respondents knew about a heat wave, less than half (46%) did something to change their behavior during a heat wave. Very few individuals used a heat hotline or cooling center (4% in Dayton, 9% in Philadelphia, 1% in Phoenix and 12% in Toronto) or sought out a cooler location (0% in Dayton, 3% in Philadelphia, 3% in Phoenix, 3% in Toronto) saying they were too far away. In Phoenix, respondents noted that air conditioning was everywhere so they felt little need to change their behavior. Of those that didn't seek a cooler location, 72% were able to correctly identify an available cooler location where they could

have gone such as a shopping center, civic building, or friends' house. In Toronto, less than 25% of people surveyed know about available cooling centers during heat events. Many people cited cost of air conditioning as a concern. There was also a large language barrier seen in the communication of heat warnings, most signs and heat warnings were in English.

Lane, et al[25] convened a focus group in NYC with 38 participants to gauge their heat wave behavior. Members of the focus groups were older adults over the age of 65, or younger adults between the ages of 18 and 64 who indicated having an older friend, relative or neighbor in NYC. NYC has a large and extensive emergency heat plan starting with the New York City Office of Emergency Management coordinating responses throughout the city. This allows for quick dissemination of communication information to vulnerable communities, and opening of air-conditioned public spaces. Similarly, older adults don't always recognize themselves as being particularly vulnerable to heat, and, in some cases, reported that they were "used to" heat in the city.[24] The majority of the focus group participants in New York City knew about open cooling centers. Some had visited and mentioned receiving heat-health information and having a positive experience. Others stated that they did not want to visit the cooling center because they did not want to leave their home and did not want to be around other "old people." Some respondents didn't feel safe enough to leave their homes because their neighborhood had a high crime rate or they didn't want to leave their pet alone. Long distances to cooling centers and lack of transport were cited as barriers to leaving home to find a place to cool down.

When 238 older adults in Quebec Canada were interviewed about their heat wave habits, 25% of them mentioned that they would refuse to be sheltered in the event of a prolonged heat wave. This was due to the idea of sleeping in a dormitory, or not seeing themselves as ill enough to need it.[21]

Alberini et al[22] conducted a survey of 1,141 individuals in five cities in Canada to determine heat wave activity and discussed knowledge of available cooling centers. When the heat event occurred 87% were aware that it was going to be hot. Most of them had heard about it on a weather forecast, or from family and friends. More than half (59%) of the respondents had never heard of cooling centers, 14% had heard of them in their city, and 29% heard of them in another city. The knowledge of available cooling centers varied by location. For example in Ontario, one third of respondents knew of them, and in Winnipeg, 68% had never heard of them. Only 12 interviewees (1%) responded that they had used them before.

There is also some evidence that cooling centers are not used during a heat wave by vulnerable populations, but rather by persons considered at lower risk of heat-related illness (e.g access to a vehicle, socially connected, ambulatory).[41] Kovats, et al reviewed literature and spoke to agencies in the U.S and Europe and stated that cooling centers were often observed and implemented.[16] The review also found that, "During a heat emergency, it may be advisable to extend the opening hours of public swimming pools, beaches, public parks, or large cooled buildings such as shopping centers. Anecdotal evidence from the US indicates that dedicated cooling centers were not well attended, and that the people who do attend are not those at most risk."[16]

Cusack et, al[23] surveyed 25 homeless people in Adelaide, Australia to gauge their extreme weather health needs. Homeless individuals are more likely to have chronic or mental illness.[42,43] The survey respondents stated that it is hard to find a public cool space without being asked to leave. During the summer months, it is common for homeless individuals to congregate and sleep in shady and green parks due to the cooler temperatures compared to concrete and asphalt. In this study, the participants requested that homeless shelters and services stay open longer during the summer months. This study suggests that planning to serve the homeless during heat months requires partnerships that link support from communities to government programs and financial resources.

### Unique needs of rural populations

Fechter-Leggett[30] compared emergency department visit counts between the years 2005–2010 for 14 states. The heat stress illness (HSI) emergency department visit data indicated that the rates were higher in rural counties compared to urban counties both overall and within each of the six climate regions. They discuss possible reasons including recreational differences, air conditioning prevalence, or less access or exposure to interventions aimed at HSI prevention. Similarly, Jagai et al[44] examined hospitalizations for heat stress in Illinois from 1987–2014, and found that the highest rates were found in the most rural and sparsely populated areas. Rural populations may be less able or willing to travel to a cooling center and may lack transportation options, or the individuals may not be able to participate in community activities aimed at heat health information dissemination. Interventions such as cooling centers have been implemented mainly in urban areas because of easy access to public transit and a broader audience in advertisement, but these studies indicate that there is a need for heat interventions in rural communities. More studies could be conducted to examine utilization of cooling centers or other heat adaptations in rural communities.

## Grey literature summary

"Grey literature," which is not peer-reviewed, also has useful information on the implementation of cooling centers. Several relevant documents and reports were identified in a search of grey literature, including documents from the government of Canada, a university, and an energy company.

Hiner and Partners[45] documented Southern California Edison's (SCE) Cool Center Program that evaluates the effectiveness and efficiency of cooling centers implemented by SCE in California's Central Valley. The Centers provide SCE customers a way to limit their energy consumption and reduce their high summer electricity bills. SCE surveyed 497 households from around the geographic area who lived within 5 miles from one of the SCE cooling center. Of the 497 interviews, 11% of those surveyed reportedly needed cooling assistance because they did not have air conditioning or never turned it on. Nearly 30% stated they would leave their homes during heat wave periods and visit cooler places such as shopping malls, the beach, friends or relative's homes, community pools, movie theatres, restaurants, community centers, or churches. Many of these options do not benefit low-income individuals due to access barriers in terms of transportation and financial resources.

In 2009, when this report was conducted, there were 16 cooling centers in three Southern California counties. SCE examined 16 existing cooling centers that they run on several factors that could affect the efficiency of a cooling center, or ability to serve the greatest number of visitors in need. The factors included, staffing levels, staff training, staff supervision, outreach and promotion, location, contractor organizational objectives, and contracts and compensation.

The evaluation found the number of staff hired to run the cooling center varied from each center, but this appeared to have little impact on if it ran efficiently or not. Commonly, informal instructions on cooling center procedures were provided to their staff. This report states, Cool Center staff should be able to "(1) explain to visitors about the Cool Center and its purpose of providing a place where people can keep cool; and (2) provide effective energy efficiency training and education." The report suggests periodic supervision and direction to provide help and oversight to the employees.

Although all Cool Centers were told to advertise their services through Public Service Announcements (PSA's), newspapers, radio, flyer distribution and other low-cost activities, they each had varied success. Monthly visits varied, ranging from 36 visitors to 8,000 visitors per month. To increase use, two centers hired the same contracting agency to employ a full-time employee dedicated to promoting their services. This contracted employee distributed flyers and spoke about the benefits of the center at many locations used by the vulnerable communities such as low cost shopping centers, libraries and local government buildings. Other centers, located in churches, targeted their promotional campaign only to church members and experienced relatively lower attendance. Visitors to the church-based cooling centers only stopped by briefly after attending church. This report recommended that SCE should hire two full time promoters to promote all 16 Cool Centers in their program. They also point out the benefit of Cool Center signs for assisting people to easily identify and locate the center.

The evaluation found that the Cool Center's functionality appeared to be more important than their actual physical location. Many SCE Cool Center visitors were those who are at the facility for another reason and then stay due to the heat. The locations of the Cool Centers supported by SCE were located in a variety of places: a multi-purpose training center, on the same property of a church operated homeless shelter, senior centers, and in classrooms that provided information about Low Income Home Energy Assistance Program (LIHEAP) and other financial support. Comfort level in visiting new or foreign locations may limit the reach these Cool Centers have. Visitors may not go into a building where they do not feel welcome or are not familiar with. Some Cool Centers only served a portion of the population, whether it's church members, the homeless, or older adults. The report recommends that centers should have comfortable seating, multiple areas to congregate for people to gather and sit comfortably, entertainment, and internet access.

The University of Michigan assessed Detroit's climate change vulnerability in the report "Foundations for Community Climate Action- Defining Climate Change Vulnerability in Detroit."[46] They created a heat vulnerability assessment to show where cooling center placement would be most ideal. The City of Detroit opens

cooling centers in facilities such as libraries and recreation centers yet only 29% of Detroit's population is within a 15-minute walking distance of a cooling center. The report did not examine accessibility of transportation services to the cooling center, but since 24% of Detroit households don't have access to an automobile, this should be examined further.

Use of cooling centers during excessive heat is included in Health Canada's *Heat Alert and Response Systems to Protect Health: Best Practices Guidebook* as an intervention for preventing HRI among vulnerable populations.[47] This guidebook states that many Canadians do not have air conditioning in their homes, so cooling facilities have been an important intervention during heat events. As in the U.S, counties use many different facilities for cooling centers including libraries, recreational community centers, city halls, places of worship, senior centers, bingo halls, museums, shopping malls and movie theatres. Health Canada recommended that cooling centers should have a generator, drinking water, medical supplies, heat-health education materials, and trained staff who can recognize the signs of heat illness. The report suggests that to prevent morbidity and mortality and increase visitors, each of the centers should have a successful outreach strategy, amenities appropriate for possible visitors, convenient hours of operation, and be easy and accessible to get to. The guidebook highlights that local communities should advertise the location of cooling centers before an extreme heat event occurs and provide a clear description of what they are and what they provide. The guidebook also recommends the creation of a recognizable sign that indicates the location of a cooling center, and an education campaign for the public to recognize cooling center signage as well as heat-health risks associated with a heat event. A case study presented in the guidebook described the "Heat and Smog Plan" passed by the City of Ottawa Council in 2004. One goal of the Heat and Smog Plan is to make sure that vulnerable populations are aware of when a heat notification occurs, know where they can go to stay cool, and get timely emergency response when needed. The plan includes recommending places the public can go to cool down such as city pools, community centers, libraries, and beaches; partnering with local movie theatres to provide free or discounted movie tickets at a location that is easily accessible to public transportation; and sending a street outreach van through Salvation Army to offer water to homeless individuals and transportation to local shelters. The guide reiterates the need for preparation before the heat season to implement a proper heat action plan during the summer.

## Effectiveness Summary, Implementation, and Barriers to Use

Although cooling centers are a widely used intervention in the United States, Europe and Canada, there have been few studies researching the direct health outcomes of using them. Most research around cooling centers focuses on an evaluation of implementation and utilization. While there is a lack of research directly assessing use of cooling centers to health outcomes, there is strong evidence that extreme heat is harmful to health and staying in a cool environment can help to maintain a safe core body temperature and reduce mortality.[5,18,48] The evidence suggests that implementation of broader heat response plans that include cooling centers as one strategy has saved lives.[15,33,49–51] The use of cooling centers is not a stand-alone strategy, and their effectiveness is enhanced if they are part of a comprehensive heat response plan.

Some common themes from the literature regarding what assisted the implementation and utilization of cooling centers were communication strategies, community outreach, a large group of diverse stakeholders, and multi-functional facilities. The literature cited many different ways that the cities kept the public up to date on cooling center location and hours before and during a heat event. These included issuing heat alerts with pertinent information, including providing real time information,[15] site locations on an easily accessible website,[26] and reaching out to vulnerable populations with pamphlets and brochures in different languages.[26] It is important to know which languages are primarily spoken[23] and where they primarily get their news from so that media can be created and disseminated properly.[19] A cooling center that serves multiple different functionalities, such as a library or community center, may be useful to attracting a larger variety of visitors.[31,45]

Barriers to access or use of cooling centers include limited access to transportation,[20,24,30] fear of leaving home or inability to leave home,[25,30] not wanting to leave pets behind,[26] populations not self-identifying as vulnerable,[24,25] and the general stigma of cooling centers being just for "old people."[25] Some individuals were unsure what to do in a cooling center, and expressed concern over sitting in a room all day with nothing to do.[24] Many of these barriers can be overcome with cooling center education and proper planning. Educating the public about what cooling centers are and who is vulnerable may help increase utilization and save lives.

# Climate Change and Energy Use

During heat waves, extensive use of air conditioning and utilities can place a strain on the electrical grid, with the possibility of cascading power failures. Warming will likely cause an increase in summer peak energy demand and increase prices during peak hours. Energy demand for A/C is expected to grow substantially in the future dependent on future income growth as well as temperature rise.[2] If the temperature of the United States increases by 1.8°F, energy used for cooling is projected to increase 5–20%.[2,52] Fossil fuels are the primary source for power generation globally. The United States' energy production and use makes up more than 84% of greenhouse gas emissions for the country.[53] Cooling and electricity consumption for air conditioning is carbon intensive. Increasing the use of A/C in the future will likely lead to increasing $CO_2$ emissions.[52] Cooling centers usually utilize air conditioning, which in most parts of the country results in carbon emissions that contribute to the greenhouse gas effect.

Cooling centers could be considered an example of "maladaptation."[54] There is an increasing need to understand the potential negative consequences of possible adaptations. Maladaptation is the concept of a treatment or adaptation becoming more harmful then helpful. While air conditioners may provide immediate health benefits, they also contribute to greenhouse gas emissions if they are using fossil fuels to provide air conditioning.

# Implementation of Cooling Centers

If a health department decides that cooling centers may be an effective strategy in their jurisdiction, there are several steps toward implementation. The specific role of the health department carrying out these steps will depend on the existing organizational frameworks and the role of partnering agencies.

## Suggested steps and considerations for implementing a cooling center

1. Scoping
    a. Are cooling centers a feasible, appropriate, and cost-effective strategy for your jurisdiction?
    b. Do cooling centers already exist in your jurisdiction? Who runs them?
2. Existing landscape and identification of partners
    a. What is the role of the health department in cooling center implementation?
    b. Do existing groups provide cooling centers?
    c. Are there other government agencies and non-profit partners that should be involved?
    d. What other key stakeholders should be involved?
    e. Is there available budget and staff?
3. Assessment of vulnerable populations and geographic scale
    a. Which populations should cooling centers target?
    b. Are there particularly vulnerable neighborhoods?
    c. Is there an existing Heat Vulnerability Index? If not can one be created?
    d. Which stakeholders can help identify populations of concern?
4. Planning
    a. Check agency policies, local laws, and ordinances
    b. Identify relevant materials and utilize existing guidance
    c. Identify staff and responsibilities
    d. Finalize locations
    e. Identify transportation options
    f. Determine thresholds for triggering cooling centers
    g. Create timeframe and budget
5. Implementation
    a. Implement plan when a heatwave occurs
    b. Communicate and provide information
6. Evaluation and publication
    a. If resources are available, the intervention should be monitored and evaluated
    b. Publication in the grey literature or peer-reviewed literature will aid other health departments

## Collaborations and Roles

Local governments and public health departments must consider what role they want to play in heat wave events, including whose responsibility it is to create cooling spaces. For example, Maricopa County, Arizona created a Heat Relief Network (HRN) with a variety of different stakeholders, each playing a role in planning and implementation.[28] They created a new system of public health response planning involving participatory modeling and complexity governance to utilize cooling centers in the region. Participatory modeling is an instrumental practice that engages relevant stakeholders and translates evidence to practice. Complexity governance is defined as "an emergency, self-organizing process and structure in which a wide range of actors including the public, government agencies, nonprofit organizations, for profit organizations and/or international organizations voluntarily and dynamically interact with one another on a relatively large scale to resolve complex social problems in an innovative and collective way."[55]

Maricopa County's HRN engages a wide range of stakeholders to fulfill its core mission- provide heat relief to the homeless, elderly, and those with disabilities, and reduce preventable heat illnesses and deaths. The Heat Relief Regional Network is a regional partnership of municipalities, nonprofit organizations, faith-based organizations, and others. HRN was created to mitigate heat health risks following an extreme heat event in 2005 that led to 35 deaths in 9 days in Maricopa County. The Heat Relief Network manages the network of organizations volunteering their facility as hydration stations, refuge locations, and water donation sites. Facilitation of the network includes onboarding new cooling center sites and listing their facility and availability on publicly available maps, disseminating an updated map of available centers, and providing information on water donations that could be provided to their facility. HRN also facilitates stakeholder meetings to provide an opportunity for public health agencies and the local NWS Weather Forecast Office to share relevant information to help educate facility managers about excessive heat warnings and heat illness prevention, recognition, and treatment.

Maricopa County's HRN shows that the best model for setting up cooling centers is to foster collaboration between many different levels of government and allow for input at all stages of development and implementation. Each member of the network has a different role that may be utilized during a different time of the recruitment, implementation and evaluation process.

## Locations

Determining potential locations for cooling centers can be a difficult task for health departments. Bradford, et al[27] describes how governments can make a heat vulnerability index to use when choosing where to locate cooling centers. Pittsburgh uses a GIS tool to optimize locations based on available walking paths and meet the demands of at-risk populations.[27] A siting plan considers cost constraints, optimizing public buildings that would be the most economically feasible in areas where there are limited cooling centers with a high amount of vulnerable populations.

### Cooling Center Locations—Sharing Information Example

New York State Department of Health (NYSDOH) conducts a yearly survey among local health departments and emergency management offices to obtain their cooling center locations for that summer. Location information including the address and phone number of a cooling center are available on the NYSDOH website.[56] Social media (e.g., Facebook, Twitter) also serves as a messaging hub. Messaging language and contact information are also shared with the local NWS affiliates.

New York State also recently launched a Summer Cooling Center Map application (**https://apps.health.ny.gov/statistics/environmental/public_health_tracking/tracker/index.html#/CCMap**), which shows the nearest cooling centers within 15 miles of an address. The public is able to get the contact information and operating hours of the facilities as well as driving, walking and public transit directions to travel to the centers.

## Existing regulations

City ordinances may also be relevant to the implementation of cooling centers. A Chicago city ordinance requires certain facilities to provide air conditioning, particularly targeting vulnerable populations.[57] Adult family care centers, assisted living establishments, long-term care facilities, and adult family care homes are required to equip, monitor and maintain automatic air-cooling systems or equipment capable of maintaining a temperature of 75 degrees and 50 percent relative humidity in all living quarters, dining areas, bathrooms, common rooms and connecting corridors.

## Factors to consider for maximizing effectiveness of cooling centers

Many factors should be explicitly considered when implementing cooling centers. These fall roughly in to three categories: setting characteristics, population characteristics, and intervention characteristics. These factors are sometimes used to assess the applicability of interventions to various settings,[58] and they determine how effective a public health intervention is.

| SETTING CHARACTERISTICS | POPULATION CHARACTERISTICS | INTERVENTION CHARACTERISTICS |
|---|---|---|
| ■ Region/state<br>■ Urban/suburban/rural/mixed<br>■ Population density<br>■ Neighborhood characteristics<br>■ Air conditioning prevalence<br>■ Greenspace<br>■ Built environment<br>■ Crime levels<br>■ Public transit availability and reliability | ■ Age<br>■ Gender<br>■ Race/ethnicity<br>■ Socio-economic status and educational attainment<br>■ Health status (such as pregnancy, existing conditions, medicine that affects the body's ability to regulate temperature)<br>■ Pet ownership<br>■ Language<br>■ Homelessness; housing status<br>■ Employment status<br>■ Accessibility; American with Disabilities Act compliance<br>■ Burden of disease and preventability (in specific jurisdiction) | ■ Educational campaign; type and content<br>■ Accessibility of center (transit, walkable, free parking lot, etc.)<br>■ Location and density of centers<br>■ Transportation, parking, transit<br>■ Convenient hours of operation<br>■ Center sponsor (church, Red Cross, local health dept)<br>■ Can free food, supplies, etc. be offered?<br>■ Heat health materials<br>■ Audience/stakeholder interest (community planning)<br>■ Alignment with other national efforts (utilization of existing tools, funding)<br>■ Cost<br>■ Feasibility<br>■ Political considerations<br>■ Interest from stakeholders<br>■ Increased energy usage (which in turn creates more greenhouse gases)<br>■ Public restroom availability<br>■ Trained staff<br>■ Water access (drinking fountain)<br>■ Back-up generator<br>■ Child-friendly<br>■ Accommodations for pets<br>■ Operating hours<br>■ Type(s) of cooling center |

### Potential Key Partners in implementation

- City/county government agencies (e.g., health departments, emergency planning departments)
- National Weather Service
- Non-profits (e.g., Red Cross)
- Meals on wheels or similar groups
- Mail carriers
- Department of Transportation: Transit agencies or regional commissions (aka regional council of governments)
- Center for Aging or other local older adult organizations
- School system
- Energy/Utility Companies
- Emergency management agencies
- Religious organizations and community organizations
- Local businesses

# Research Gaps

There are many aspects of cooling center implementation that remain unanswered. Health departments and other organizations implementing cooling centers can add to the scientific knowledge base by evaluating and publishing data on the implementation of their centers.

## Designing Evaluation of Cooling Center Intervention

Although cooling centers are a commonly used method for providing reprieve during heat events, there is limited published data to indicate measurable health impacts beyond reporting the number of persons who use cooling centers. Thus, there is a need for research and evaluation on the implementation of cooling centers during heat events. If interventions such as establishing cooling centers are not properly evaluated, their effectiveness cannot be fully determined. It is imperative to understand the specific intervention characteristics that limit or promote effectiveness. Some characteristics could include: advertisements via an educational campaign; density of centers in an area; accessibility to center via public transit, walking; whether it was sponsored (e.g., Health Department, Red Cross); whether food was provided; activities offered; were pets allowed; targeted audience, etc. Each characteristic plays an important role in the success or failure of a cooling center.

Ideally, prior to implementing a cooling center operation officials would design an evaluation plan. The evaluation plan could monitor the execution (e.g., process evaluation) and the effects (e.g., outcome evaluation) of the cooling center. Further, cost-benefit analyses of cooling center use are surprisingly scarce. Such data could be critical during prolonged heat events, for staffing cooling centers, providing

transportation and outreach to vulnerable populations, and determining center siting to maximize use. Incentive programs between cooling center sites, corporations, and visitors have been anecdotally identified, though, not studied specifically for their efficacy.

Logic models are useful tools that can help identify outcomes at the end of the study period for evaluation. They require the practitioner to take a critical look at all of the components required to complete the intervention, aiding in planning and providing a roadmap for activity. Ultimately, the logic model can be used to guide the process evaluation.

Behavioral research, particularly around populations who don't utilize cooling centers during heat events, could provide insight into the complex scenarios that prohibit individuals from taking advantage of cooling centers. Developing *a priori* hypotheses should be central to the research project.

## Comparison Populations

While cooling centers are becoming more common, those who are most vulnerable do not always use them. More research is needed to understand the numerous factors that keep individuals from using cooling centers.

There are vulnerable populations who may not have access to cooling centers due to lack of transportation or being home bound. Additionally, work conditions may prevent some populations from accessing cooling centers. Seasonal farm workers, for instance, may be exposed to excessive heat conditions throughout the day making it unlikely that they would leave work to access a cooling center. In New York State, some employers have established cooling shelters on site for the workers, and the California Division of Occupational Safety and Health and Washington State Department of Labor and Industries have both established policies that require all employers for outside workers to provide access to shade or other ways to reduce body temperature.[59,60]

Social networks were particularly protective of elderly individuals during the 1995 Chicago heat wave.[61] When individuals have strong connections with other individuals, their social capital increases. Studies have suggested that among aging populations, communities with high social capital (e.g., senior housing facilities) may be more effective at responding to external health threats, such as extreme heat, than communities with lower social capital.[62] However, there is a lot of room for more research on the role of social capital and vulnerability during heat events. There is little research that isolates the effect of social capital on behavior to use or access a cooling center during a heat event. One may hypothesize that being well connected confers a higher likelihood to partake in cooling center events.

## Selected Resources

**Health Canada Heat Alert and Response Systems to Protect Health: Best Practices Guidebook**[63]

A guidebook outlining information and strategies on protecting people from extreme heat events, including guidance on developing a heat alert and response system. Available at: http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/response-intervention/index-eng.php

**Arizona Heat Safety Resource Guide: Resources for Local Health Officials and Public Information Officers During Extreme Heat Events**[64]

A resource guide to provide local health officials and public information officers with information on health impacts of Extreme Heat Events, decision-support tools, and useful resources and expertise for prevention of heat related illnesses. Available at: http://www.azdhs.gov/documents/preparedness/epidemiology-disease-control/extreme-weather/heat/az-heat-safety-resource-guide.pdf

**Minnesota Extreme Heat Toolkit**[65]

A toolkit to provide information to local governments and public health professionals about preparing for and responding to extreme heat events. Available at: http://www.health.state.mn.us/divs/climatechange/docs/mnextremeheattoolkit.pdf

**Health Canada Communicating the Risks of Extreme Heat**[66]

A toolkit intended for use by public health and emergency management officials who are developing or updating heat-health communication strategies. Available at: http://www.hc-sc.gc.ca/ewh-semt/pubs/climat/heat-chaleur/index-eng.php

**State of California Emergency Management Agency Heat Contingency Plan & Resources**[67]

A plan that describes state operations during heat-related emergencies and provides guidance for state agencies, local government, and non-governmental organizations in the preparation of their heat emergency response plans and other related activities. Available at: http://www.caloes.ca.gov/PlanningPreparednessSite/Documents/ExcessiveHeatContingencyPlan2014.pdf

**Kansas Extreme Heat Toolkit**[68]

A toolkit to provide information to local governments and public health professionals about preparing for and responding to extreme heat events. Available at: http://keap.kdhe.state.ks.us/Ephtm/EphtContent/documents/Extreme%20Heat%20Toolkit%2020140519.pdf

**World Health Organization Heat-Health Action Plans Guidance**[69]

Document describing the importance of the development of heat–health action plans, their characteristics and core elements, with examples from several European countries that have begun their implementation and evaluation. Available at: http://www.euro.who.int/__data/assets/pdf_file/0006/95919/E91347.pdf

**Excessive Heat Events Guidebook**[70]

Guidebook from CDC, EPA, and FEMA that provides critical information that local public health officials and others need to begin assessing their EHE vulnerability and developing and implementing EHE notification and response programs. Available at: https://www.epa.gov/sites/production/files/2016-03/documents/eheguide_final.pdf

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**Climate Change and Extreme Heat: What You Can Do to Prepare**[71]
CDC and EPA guidebook that answers some of the key questions about extreme heat in a changing climate: why extreme heat is on the rise, how it might affect you, and what you can do before and during an extreme heat event to reduce your health risk. Available at: **https://www.cdc.gov/climateandhealth/pubs/extreme-heat-guidebook.pdf**

**FEMA Preparing for Extreme Heat**[72]
Tips for individuals to prepare for extreme heat events. Available at: **https://www.fema.gov/media-library-data/1463677085878-9910a9fefba8ab4d6fc8e9195b1da115/Preparing_for_Extreme_Heat_EA_JS_edits_final_508.pdf**

**Ready.gov: Extreme Heat Safety Tips**[73]
Explains what actions you can take when the weather is extremely hot and how to understand heat alerts from the National Weather Service that you could receive in your local area. Available at: **https://www.ready.gov/heat**

**National Weather Service Heat Safety Tips and Resources**[74]
Learn about the dangers of heat, how to prepare for excessive heat, and how to stay safe during an excessive heat event. Available at: **http://www.nws.noaa.gov/os/heat/**

**OSHA Heat Safety Tool**[75]
An App that allows workers and supervisors to calculate the heat index for their worksite, and, based on the heat index, display a risk level to outdoor workers. Available at: **https://www.osha.gov/SLTC/heatillness/heat_index/heat_app.html**

**Ready New York Beat the Heat**[76]
A brochure outlining safety tips during heat events. Available at: **https://www1.nyc.gov/assets/em/downloads/pdf/heat_brochure_english.pdf**

**National Integrated Heat Health Information System**[77]
An inter-agency system that facilitates an integrated approach to providing a suite of decision support services that reduce heat-related illness and mitigate other effects of extreme heat. Available at: **https://toolkit.climate.gov/nihhis/**

**Pacific Gas and Electric Company: Learn About Cooling Centers**[78]
Website outlining cooling centers and locations. Available at: **https://www.pge.com/en_US/safety/emergency-preparedness/natural-disaster/heat/cooling-centers.page**

Disclaimer: The scientific results and conclusions, as well as any views or opinions expressed herein, are those of the authors and do not necessarily reflect the views of CDC, NWS, NOAA, or the Department of Commerce.

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# Appendix

## Methods

An initial scoping review of peer-reviewed literature and news sources was conducted. This review was a broad search on the topic of heat-related illness, including the terms cooling centers, cooling centers used as public health intervention, heat, heat wave, air conditioning, cooling, and high temperature. After informal review of these results, a formal review of peer-reviewed literature was conducted. Medline, Embase, Global Health, Environmental Science Collection, ProQuest Central, and Scopus databases were searched for English-language peer-reviewed literature using the search strategy outlined in table 1 and the boxes below. Publications through November 15, 2016 were included in the initial search strategy. The resulting database of peer-reviewed literature was reviewed. The titles and abstracts of each citation was reviewed to determine relevance. The full text of potentially relevant articles was reviewed to determine final relevance and inclusion. References from relevant articles were scanned for other relevant material, and an existing Cochrane review on heat-related illness interventions was also reviewed for relevant material. Additional expert opinion was sought to identify gray literature and other relevant publications.

### Key questions:

- Does the use of cooling centers by vulnerable populations reduce heat-related illness and death during heat waves?
- What characteristics of cooling centers impact effectiveness, and how?
- What are the gaps in information that need to be researched further?

| INTERVENTION TERMS | EXPOSURE TERMS |
|---|---|
| cooling center, cooling centre, cooling station, cooling shelter, cooling tent, cooling site | Heat wave, extreme heat, heat event, climate change, global warming, weather pattern, adaptation, or one of the terms extreme, high, rising, or elevate within two words of temperature |

Table 1: Search results included at least one intervention term and one exposure term. Exposure terms

Example of search strategy used for Medline. * indicates truncated results were accepted, ADJ2 indicates terms are adjacent within two words.

```
cooling center* OR cooling centre* OR cooling station* OR
cooling shelter* OR cooling tent* OR cooling site*)
AND
(Heat wave* OR extreme heat OR heat event* OR ((extreme
OR high OR rising OR elevate* OR dangerous) ADJ2
temperature*) OR climate change* OR global warming OR
weather pattern* OR adaptation*)
AND
Limit English
```